Online Courses and Materials That Provide True Technology Integration Across the Sciences

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The Concord Consortium

Realizing the Promise of Education Technology

- A nonprofit educational research and development organization based in Concord, Massachusetts.

- We create interactive materials that leverage the power of information technologies.

- Our goal is to improve learning opportunities for ALL students.

Levels of Integration

- Type of activity/exploration.
- Look and feel of symbolic representations.
- Smooth integration of new materials with other online course content.

Static attempt at teaching phase change

The phases of matter

Solid, liquid, and gas

Most of the matter you find around you is in one of three phases: solid, liquid, or gas. A **solid** holds its shape and does not flow. The molecules in a solid vibrate in place, but on average, don't move far from their places. A **liquid** holds its *volume*, but does not hold its shape — it flows. The molecules in a liquid are about as close together as they are in a solid, but have enough energy to exchange positions with their neighbors. Liquids flow because the molecules can move around. A **gas** flows like a liquid, but can also expand or contract to fill a container. A gas does not hold its volume. The molecules in a gas have enough energy to completely break away from each other and are much farther apart than molecules in a liquid or solid.

Intermolecular forces

When they are close together, molecules are attracted through *intermolecular forces*. These **intermolecular forces** have different strengths for different molecules. The strength of the intermolecular forces determines whether matter exists as a solid, liquid, or gas at any given temperature.

Temperature vs. intermolecular forces

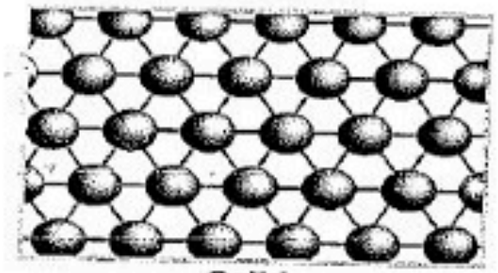
Within all matter there is a constant competition between temperature and intermolecular forces. The kinetic energy from temperature tends to push molecules apart. When temperature wins the competition, molecules fly apart and you have a gas. The intermolecular forces tend to bring molecules together. When intermolecular forces win the competition, molecules clump tightly together and you have a solid. Liquid is somewhere in the middle. Molecules in a liquid are not stuck firmly together, but they cannot escape and fly away either.

Strength of intermolecular forces

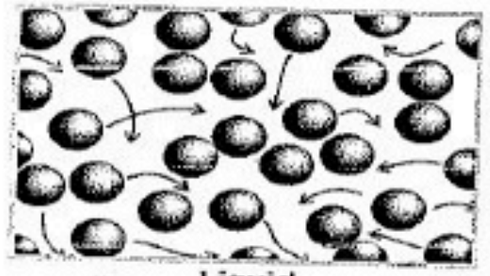
Iron is a solid at room temperature. Water is a liquid at room temperature. This tells you that the intermolecular forces between iron atoms are stronger than those between water molecules. In fact, iron is used for building things because it so strong. The strength of solid iron is another effect of the strong intermolecular forces between iron atoms.

Temperature

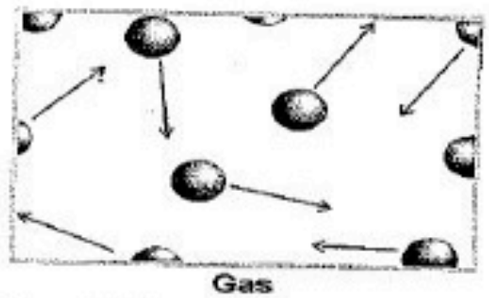
As the temperature changes, the balance between temperature and intermolecular forces changes. At temperatures below 0°C, the intermolecular forces in water are strong enough to overcome temperature and water becomes solid (ice).



Solid



Liquid



Gas

Figure 7.11: *Molecules (or atoms) in the solid, liquid, and gas phases.*

Ideal Learning Environment

- Dynamic nature of atomic/molecular systems not easily conveyed with text and static images.

- Animations help, but don't allow students to construct knowledge. Student is passive learner.

- **Models which are computed in real-time allow users to probe the simulation by changing parameters. Student becomes an active learner.**

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The Modeling Environment

The Molecular Workbench – a molecular dynamics tool.

- Open-source cross-platform molecular dynamic engine.
- Calculates complex real-time interactions between atoms and molecules.
- User friendly interface for creating custom model-based activities.

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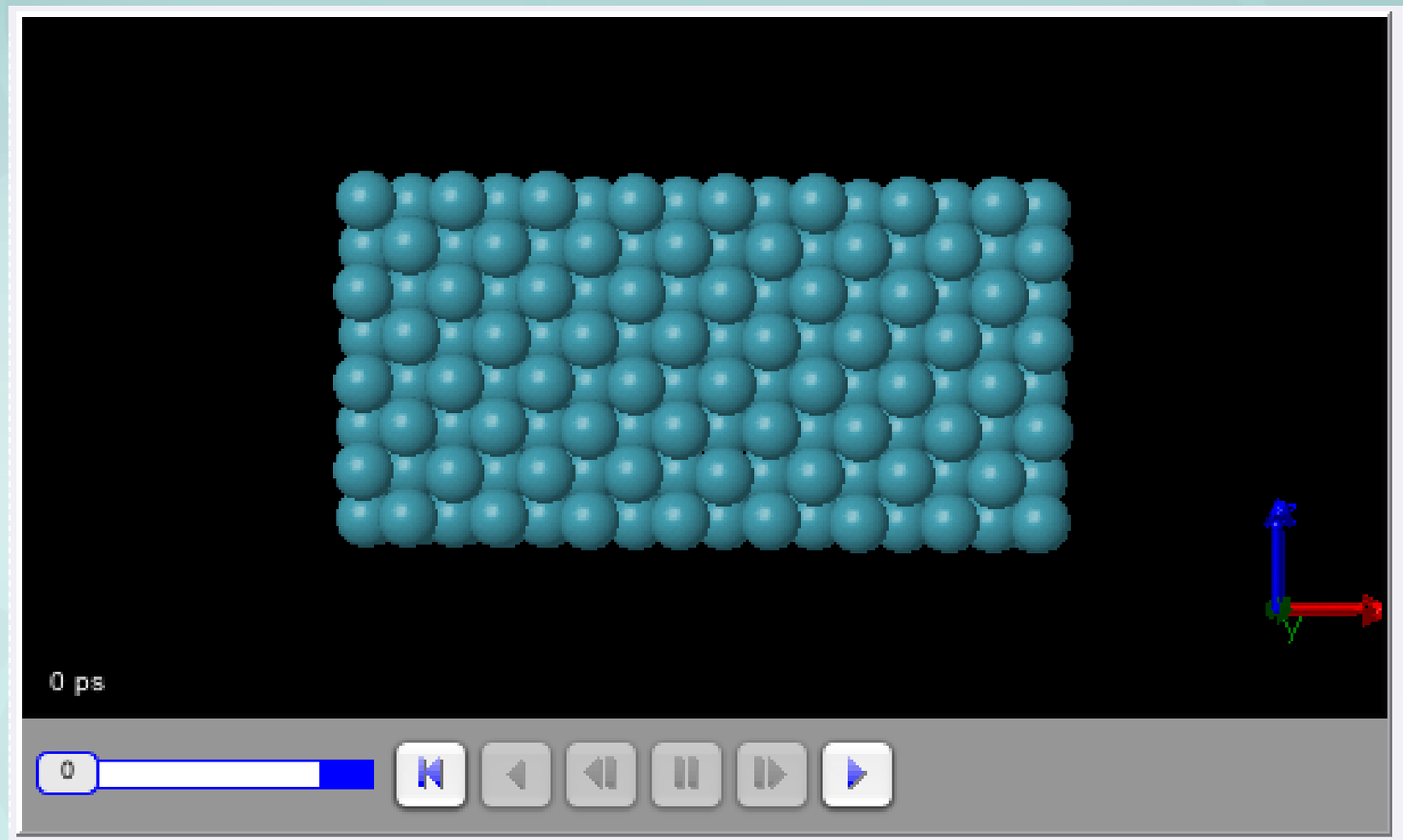
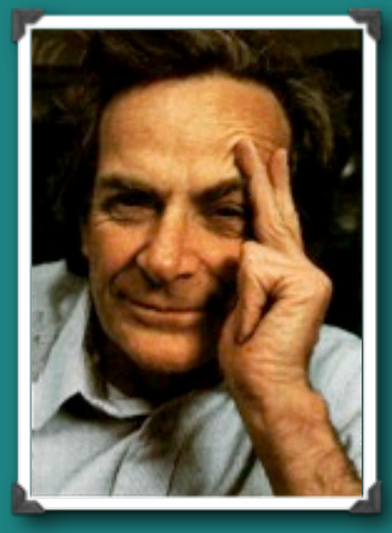
Dynamic Phase Change Model



Heat Cool Snapshot

A concise summary of the last 100 years of science is that atoms and molecules are 85% of physics, 100% of chemistry and 90% of modern molecular biology.

–Leon Lederman



... all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.

– Richard Feynman

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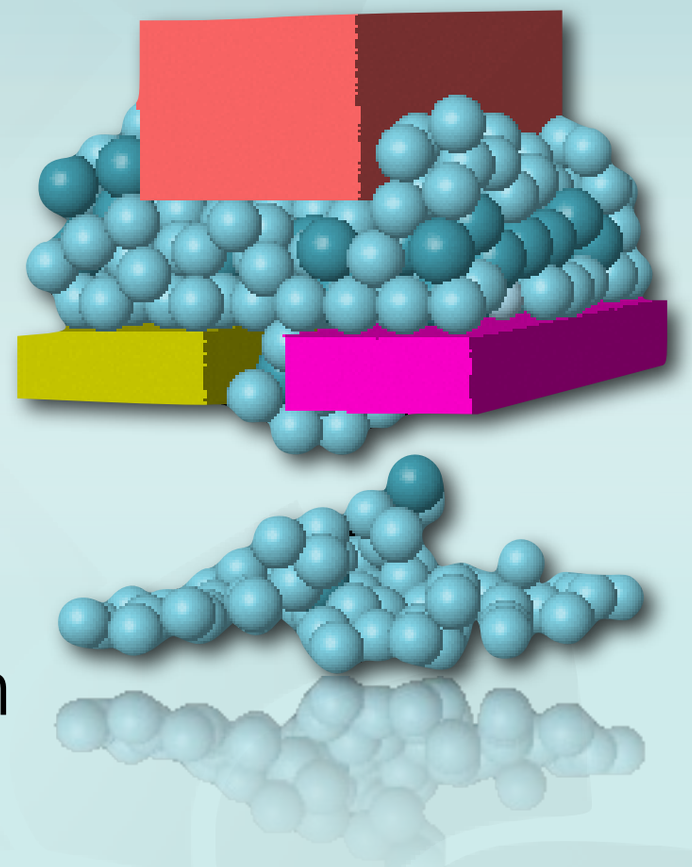
Science of Atoms and Molecules Activities

	Physics	Chemistry	Biology
Motion and Energy	Atoms and Energy	Phase Change	Diffusion, Osmosis, and Active Transport
	Heat and Temperature	Gas Laws	Cellular Respiration
Charge	Electrostatics	Intermolecular Attractions	Four Levels of Protein Structure
	Electricity	Molecular Geometry	Protein Partnering and Function
		Solubility	
Atoms and Molecules	Atomic Structure	Chemical Bonds	Lipids and Carbohydrates
	Newton's Laws at the Atomic Scale	Chemical Reactions and Stoichiometry	Nucleic Acids and Proteins
			DNA to Proteins
Light	Atoms, Excited States, and Photons	Chemical Reactions and Energy	Photosynthesis
	Spectroscopy		

http://ri-itest.portal.concord.org/preview/

Methods to Integrate Activities into Online Courses

- Link to activity previews directly from links within courses.
  - Could be direct links
  - Links from within presentations



- Use portal to set up classes and generate reports.

- In talks with VHS about D2L integration using single-sign-on standard – IMS Basic Learning Tools Interoperability

Student Data/Reporting

RI-ITEST DIY: http://ri-itest.diy.concord.org/reports/131/otml?group_id=be8ba548-d701-102b-a487-005056801240&group_lis...

Heat and Temperature (v3)

Teacher: Daniel Damelin
Class: chem1

Show students who completed at least 1 % Update List

Print All Users

User	1. Compare the motion of the air ...	2. The temperature of a substance...	3. A substance composed of atoms ...	4. Which type of atom has the gre...	5. The yellow and pink atoms in t...	6. What did you observe about the...	7. If we add another box to the m...	8. Describe how changing the numb...	9. How is the average KE affected...	10. What will happen to the temper...	11. What do you think happens that...	12. W down temper of
		50%		75%		25%	50%	50%		0%		
Report	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TestA Damelin TestB Damelin 38%	They move fast.	● Both the s...	Atom a will be slower.	● The pink a...	Kinetic energy is from the spe...	● Some atoms...	● Be the sam... ● Be the sam... ● Depend on ...	● Changing n...	The average goes up and down.	No Answer	No Answer	No Answ
TestB Damelin 100%	They move fast.	● Both the s...	Atom a will be slower.	● The pink a...	Kinetic energy is from the	● Some atoms...	● Be the sam... ● Be the sam... ● Depend	● Changing n...	The average goes up and down	● They both ...	blah blah blah	blah bla

Student Data/Reporting

RI-ITEST DIY: http://ri-itest.diy.concord.org/reports/131/otml?group_id=be8ba548-d701-102b-a487-0...

Heat and Temperature (v3)

TestC Damelin

Teacher: Daniel Damelin
Class: chem1
Other Group Members:

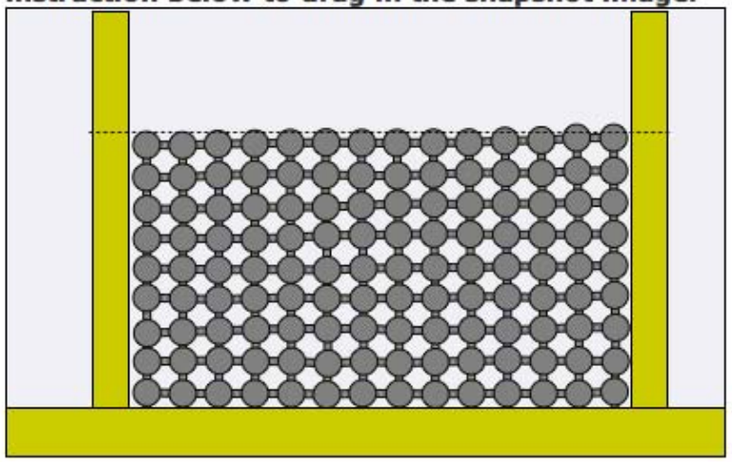
Print

1. Compare the motion of the air molecules at high and low temperatures.
They look the same to me.

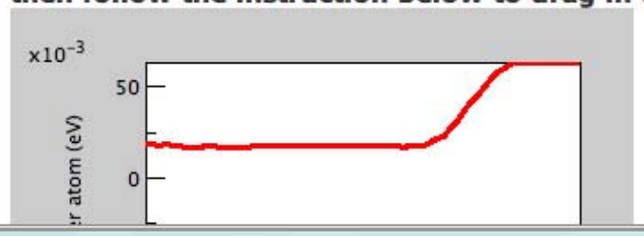
4. Which type of atom has the greater mass?

● The pink atoms.

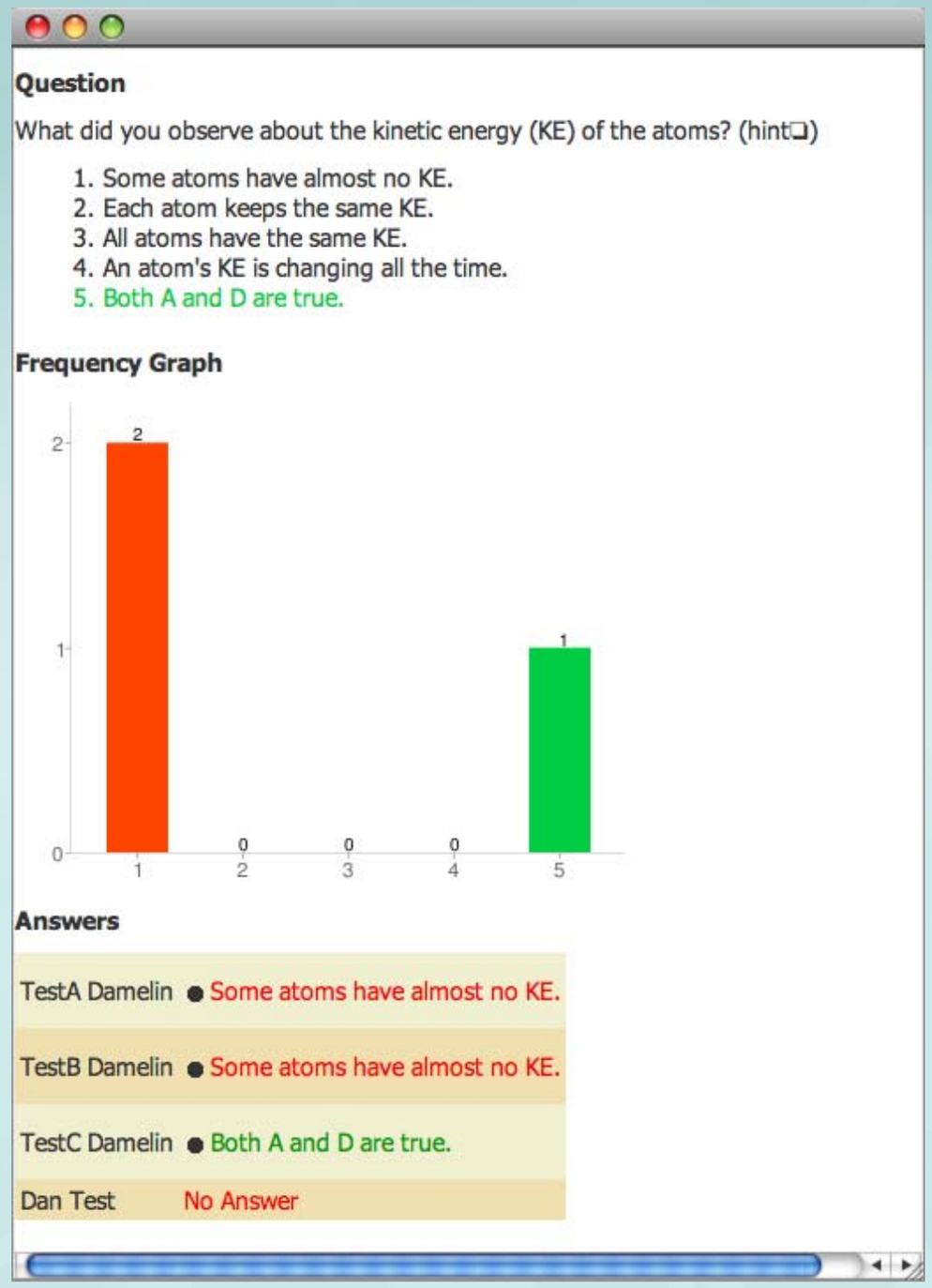
17. Take a snapshot of the model that shows thermal expansion, and then follow the instruction below to drag in the snapshot image.



18. Take a snapshot of the graph that shows the increasing of energy when heated, and then follow the instruction below to drag in the snapshot image.



Student Data/Reporting



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Explore other projects at:
http://www.concord.org/projects